REMARKS

The Advisory Action mailed September 3, 2002 contained the Examiner's views why the rejections in the Final Rejection were being maintained.

The Examiner stated that (1) "metastable" was not present in the specification and (2) the term was deemed new matter. The independent claims have been changed to replace the phrase "metastable excited state which is" to read "a quasi-stable level energy," a phrase that is clearly supported in the specification at least in the paragraph bridging pages 5 and 6. Applicant submits that those of skill in the art recognize and understand that the terms used in the specification refer to a metastable state; claim changes have been made, however, in a sincere attempt to advance prosecution.

Claim 1 has been amended also to state that the inert gas compound contains "only" at least one of a krypton and a xenon gas. The change is made better to distinguish the claimed invention over the prior art.

Applicant respectfully submits that neither of the references newly cited in the Final Rejection properly teach or suggest the advantages to be gained by using krypton and/or xenon in the inert

gas component to excite the gaseous molecules to a quasi-stable level energy. Applicant points out that in Matsui et al. '630, the rare gas includes He and Ne in addition to Xe (column 5, lines 25-35). In Ueno et al. '199, only the sort of rare gas is listed in the energy level, but it is disclosed that He, Ne or Ar can be used as the gas to be pre-excited (column 2, second paragraph). Accordingly, Ueno et al. '199 does not teach the use of Kr gas and/or Xe gas as employed in the instantly claimed process. This application is characterized by using the inert gas component containing only Kr gas and/or Xe gas to provide a mixture of the inert gas component and gaseous molecules. The advantage of the use of only Kr and/or Xe gas as the inert gas component is concretely demonstrated by the experimental results reported below.

Experiment

An experiment was carried out using the film-forming equipment shown in Fig. 1 in this application.

First of all, the interior of the vacuum vessel 1 was evacuated to a pressure of no more than 1 x 10^{-5} Torr with the pump 100. A silicon substrate was then placed on the holder 8 and heated to 500°C. Thereafter, an inert gas and an oxygen gas were introduced into the vacuum vessel 1 through the quartz tube 4 until

the interior pressure of the vacuum vessel 1 reached to 1 Torr. In this case, the mixture ratio of the inert gas and the oxygen gas was set to 25:1, and the total flow rate was set to 100 sccm. Then, a microwave with a frequency of 2.45MHz and a power of 100 W was introduced into the quartz tube 4 through the microwave cavity 3 to generate a plasma composed of the mixture of the inert gas and the oxygen gas. The silicon substrate was then exposed to the plasma for 50 minutes to form a SiO_2 film on the silicon substrate. He, Ne, Ar, Kr, and Xe were employed as the inert gases.

The thicknesses and the interface trap densities of the SiO_2 films are listed with respect to each inert gas.

Thickness of the SiO_2 film

inert gas: none (only oxygen gas)	2.0 nm
inert gas: He	2.8 nm
inert gas: Ne	3.2 nm
inert gas: Ar	3.5 nm
inert gas: Kr	8.3 nm
inert gas: Xe	6.8 nm

The thickness was measured with an ellipsometer using a light beam with a wavelength of 632.8 nm.

Interface trap density (Dit value) at the boundary between the SiO_2 film and the Si substrate

inert gas: none (only oxygen gas)	5×10^{12} ($/cm^2/eV$)
inert gas: He	4.5×10^{12} ($/cm^2/eV$)
inert gas: Ne	4.7×10^{12} ($/cm^2/eV$)
inert gas: Ar	3.1×10^{12} ($/cm^2/eV$)
inert gas: Kr	2.6×10^{11} ($/cm^2/eV$)
inert gas: Xe	7.8×10^{11} ($/cm^2/eV$)

As to the thickness of the SiO_2 film, the use of the Kr gas or the Xe gas can enhance dissociation of the oxygen molecules into the oxygen atoms, and thus, enhance oxidation for the silicon substrate. As a result, the thickness of the SiO_2 film formed by using the Kr gas or the Xe gas clearly is much larger than a SiO_2 film formed by using He gas, Ne gas, or Ar gas.

With the dit value, the use of the Kr gas or the Xe gas can dissociate the oxygen molecules into the oxygen atoms without ionization of the oxygen molecules. Therefore, the boundary between the SiO_2 film and the silicon substrate is not almost damaged by the ionized oxygen elements. In contrast, using He gas, Ne gas and Ar gas ionizes the oxygen molecules considerably. Therefore, the boundary between the SiO_2 film and the silicon

substrate is minimally damaged by the ionized oxygen elements. As a result, the Dit value when using the Kr gas or the Xe gas is much smaller by single digit dimension than the one at the use of He gas, Ne gas or Ar gas.

Reconsideration of the case in view of the foregoing changes and remarks is earnestly solicited.

Respectfully submitted,

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Serial No. 09/646,988

MARKUP

1. (Twice Amended) A film-forming method of supplying gaseous molecules, each composed of plural atoms, onto a substrate, said film-forming method comprising:

providing a substrate;

providing a mixture of an inert gas component containing only at least one of a Kr gas and a Xe gas and a gas component containing said gaseous molecules;

generating a plasma of said mixture, to excite molecules of said inert gas, and thus, to excite said gaseous molecules through the collision between said excited molecules of said inert gas and said gaseous molecules to [metastable excited state which is] a quasi-stable level energy required to dissociate said gaseous molecules into their respective elements; and

supplying said elements of said gaseous molecules onto said substrate.

Serial No. 09/646,986

Twice

10. (Amended) A film-forming method of supplying gaseous molecules, each composed of plural atoms, onto a substrate, said film-forming method comprising:

providing a substrate;

providing a mixture of an inert gas component containing at least one of a Kr gas and a Xe gas and a gas component containing said gaseous molecules;

generating a plasma of said mixture, to excite molecules of said inert gas, and thus, to excite said gaseous molecules through the collision between said excited molecules of said inert gas and said gaseous molecules to [metastable excited state which is]

a quasi-stable level energy

required to dissociate said gaseous molecules into their respective elements; and

supplying said elements of said gaseous molecules onto said substrate,

said substrate being a silicon substrate;

said gaseous molecules containing Si elements and nitrogen molecules to be dissociated into their respective elements;

said inert gas component further containing He gas.